VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examinations and Syllabus

M.Tech Highway Technology (CHT)

(Effective from Academic year 2020 - 21)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech HIGHWAY TECHNOLOGY (CHT)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical	Skill Development Activities (SDA)	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20CHT11	Applied Statistics for Highway Engineers	03	--	02	03	40	60	100	4
2	PCC	20CHT12	Pavement Materials	03	--	02	03	40	60	100	4
3	PCC	20CHT13	Pavement Analysis and Design	03	--	02	03	40	60	100	4
4	PCC	20CHT14	Road Geometric Design	03	--	02	03	40	60	100	4
5	PCC	20CHT15	Traffic Engineering and Management	03	--	02	03	40	60	100	4
6	PCC	20CHTL16	Pavement Engineering Lab-I	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	02	--	--	03	40	60	100	2
			TOTAL	**17**	**04**	**10**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Skill development activities:
Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.
The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.
The students shall
(1) Gain confidence in modelling of systems and algorithms.
(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
(3) Handle advanced instruments to enhance technical talent.
(4) Involve in case studies and field visits/ field work.
(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.
All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ seminar	Skill Development Activities (SDA)	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20CHT21	Highway Construction Technology	03	--	02	03	40	60	100	4
2	PCC	20CHT22	Detailed Project Report Preparation	03	--	02	03	40	60	100	4
3	PCC	20CHT23	Pavement Management System	03	--	02	03	40	60	100	4
4	PEC	20CHT24X	**Professional Elective 1**	04	--	--	03	40	60	100	4
5	PEC	20CHT25X	**Professional Elective 2**	04	--	--	03	40	60	100	4
6	PCC	20CHTL26	Pavement Engineering Lab-II	--	04	--	03	40	60	100	2
7	PCC	20CHT27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				**17**	**06**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		**Professional Elective 2**	
Course Code under 20CHT24X	**Course title**	**Course Code under 20CHT25X**	**Course title**
20CHT241 /20 CIM 241	Construction Equipment and Safety Management	20CHT251	Special Concrete
20CHT242	Design of Bridge and Grade Separated Structures	20CHT252	Road Safety Engineering & Management
20CHT243/ 20CIM243	Ground Improvement Techniques	20CHT253	Urban Public Transport
20CHT244/ 20CIM244	Soil Mechanics for Pavement Engineers	20CHT254/ 20CIM254	Low volume Roads Engineering

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini –Project/ Internship	Skill Development activities (SDA)	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20CHT31	Construction Planning and Economics	03	--	02	03	40	60	100	4
2	PEC	20CHT32X	**Professional elective 3**	03	--	--	03	40	60	100	3
3	PEC	20CHT33X	**Professional elective 4**	03	--	--	03	40	60	100	3
4	Project	20CHT34	Evaluation of Project phase - 1	--	02	--	--	100	--	100	2
5	PCC	20CHT35	Mini-Project	--	02	--	--	100	--	100	2
6	Internship	20CHTI36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				**09**	**04**	**02**	**12**	**360**	**240**	**600**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		**Professional elective 4**	
Course Code under 20CHT32X	**Course title**	**Course Code under 20CHT33X**	**Course title**
20CHT321	Construction Contract Management	20CHT331	Sustainable Concrete Pavements
20CHT322	Intelligent Transportation Systems	20CHT332	GIS and Remote Sensing application in Transportation Engineering
20CHT323/ 20CIM323	Special problems in road construction	20CHT333/ 20CIM333	Transportation Planning
20CHT324/ 20CIM324	Sustainable Construction	20CHT334/ 20CIM334	Construction & Demolition Waste Management

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Project	20CHT41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

COURSE TITLE: APPLIED STATISTICS FOR HIGHWAY ENGINEERS

[As per Choice Based Credit System (CBCS) scheme]

Semester I

Subject Code	20CHT11	CIE Marks	40
Number of Lecture Hours/Week	3:0:2	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the use of statistical tools to express the traffic data for better interpretation.
2. Apply probability concept to understand the vehicular flow behavior helping the planners to predict traffic flow.
3. Use appropriate statistical testing tools to check the degree of accuracy in the traffic data analysis.
4. Test the hypothesis and assess the error involved in the data analysis.
5. Use software tools like MATLAB, MINITAB etc., for analysis of traffic data and also use curve fitting techniques for predicting the performance trends.

Modules

Module -1

Introduction to statistical methods: Definition, Scope, and Limitations of Statistics. Variables and their types. Types of data – Primary and Secondary data, sources of secondary data. Scales of measurement of data. Methods of collection of data. Reliability and Accuracy of data.

Presentation of data -Tabular methods (Frequency distribution for both discrete and continuous data) and Graphical methods (Bar diagrams, Pie diagrams, Histogram – location of mode using Histogram, Frequency curves and polygons, Line graph, Ogive curve – location of median using ogives, Scattered diagram. Advantage and disadvantage of both tabular and graphical methods. Summarizing data. Measure of central tendency – and Measures of dispersion/ variation. Merits and Demerits of measures of central tendency and dispersion. Measures of Skewness and Kurtosis.

Activities: Group based assignment using excel to solve problems on frequency distribution, graphical methods, measures of central tendency and dispersion

Module -2

Probability & Probability distribution for Traffic Engineering Design: Definition of Sample space, mutually exclusive, equally likely, independent outcomes, favorable events, Definitions of different types of probability, addition and multiplication rule of probability, conditional probability, Bayes theorem. Random variables, Definition of probability mass function (pmf) based on discrete random variable and probability density function (pdf) based on continuous random variable. Expected value and Variance of discrete and continuous random variables. Cumulative distribution function.

Joint probability distribution. Special discrete probability distributions like Bernouli, Binomial and Poisson. Special continuous probability like Normal distribution and Standard normal distributions. Problems based on probability distributions.

Activities: Group based assignment on finding probabilities of different distribution using excel

Module -3

Sampling Techniques: – Definition of basics concepts of sampling, advantages and disadvantages of sampling, Probability and non-probability sampling techniques, Sampling variation. Definition of sampling distribution, sampling distribution of the sample mean (t-distribution), sample variance (Chi-square distribution), sample proportion (Z-distribution), ratio of sample two sample variance (F-distribution) Central limit theorem, Sampling error, Sample size distribution.

Module -4

Statistical Inference: Basics of testing of hypothesis.

Parametric tests: Z-test for mean and proportion, Students' t-test, F-test, Analysis of Variance

Non-parametric tests: Chi-square test, Fisher's exact probabilities, Mann-Whitney U test, Wilcoxon signed rank test, Kruskal-Wallis test

Activities: Group based assignment on Students' t-test and ANOVA using excel

Module -5

Correlation: Definition of correlation, Nature of correlation, Types of correlation, Measures of correlation

Regression: Curve fitting by the method of least squares, Simple Linear Regression & Multiple linear regression. Use of statistical software like SPSS, R, Python, MATLAB.

Course outcomes:

After studying this course, students will be able to:

1. Use statistical tools to express the traffic data for better interpretation.
2. Apply probability concept to understand the vehicular flow behavior helping the planners to predict traffic flow.
3. Use appropriate statistical testing tools to check the degree of accuracy in the traffic data analysis.
4. Test the hypothesis and assess the error involved in the data analysis.
5. Use software tools like SPSS, R, Python MATLAB etc., for analysis of traffic data and also use curve fitting techniques for predicting the performance trends.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Problem Analysis.*
- *Critical thinking*
- *Interpretation of data.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Johnson R and G Bhattacharya, "Statistics – Principles and methods"- John Wiley & sons, New york, 1985
2. L.R Kadiyali, "Traffic Engineering"- Khanna Publishers New Delhi
3. Kumar Molugaram and G. Shanker Rao, "Statistical Techniques for Transportation Engineering"- BS Publications

Reference Books:

1. Medhi, "Introduction to statistics"- New Age Pub, New Delhi
2. Benjamin Jack R and Cornell C Allin, "Probability Statistics & Decisions for Civil Engineers"- McGraw Hill Co.
3. Agarwal, B.L, "Basic Statistics"- 3rd edition, New Age Pub. New Delhi.
4. Martin Wohl, Brian V Martin, "Traffic System Analysis"- Mc Graw Hill Series

COURSE TITLE: PAVEMENT MATERIALS

[As per Choice Based Credit System (CBCS) scheme]

Semester I

Subject Code	20CHT12/20CIM12	CIE Marks	40
Number of Lecture Hours/Week	3:0:2	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the basic construction materials and their suitability as road materials.
2. Analyze the aggregates and design aggregate gradation for construction of pavement layers.
3. Characterize the binder material for bituminous roads and provide an optimum bituminous mix design.
4. Understand mix design using different materials for various components of a CC pavement.
5. Understand and propose soil stabilization techniques for highway construction using locally available materials.

Modules

Module -1

Soil Mechanics–

Basic soil properties, methods to determine strength of soil, Soil compaction for use in fill and subgrade of roads, compaction studies in laboratory and field, properties of compacted soils; strength characteristics of soil; field testing and applications

Module -2

Aggregates–Origin, classification, Equipment, properties. Tests and specifications on road aggregates for flexible and rigid pavements. Importance of aggregate gradation problems on Rothfutch's and Critical sieve methods and Shape factor in mix design.

Module -3

Bituminous binders – different types, properties and uses, physical tests on bitumen, Rheological and pavement performance related properties, Modified binders, ideal pavement binders, characteristics and applications in road construction, criteria for selection of different binders, characterization of bituminous binders.

Bituminous mixes, types, requirements, properties, tests, Marshall Method of mix design, Criteria and super pave mix design, Additives & Modifiers in Bituminous mixes, problems on mix design. Performance based mix design

Module -4

Portland cement and cement concrete for use in road works – requirements, design of mix for CC pavement as per BIS/PCA, use of additives, IRC specifications & Tests, joint filler and sealer materials and their testing

Module -5

Soil stabilization – principle, methods and tests, proportioning of materials and mix design, application of Rothfutch's method. Marginal and waste materials in road construction, their properties and scope in road construction. Use of Fly-ash in road embankment and cement concrete mixes, use of chemical stabilizers in road Construction. Use of Natural stabilizers; characterization of stabilized mixes.

Course outcomes:

After studying this course, students will be able to:

1. Identify and select based on their characteristics the basic construction materials for road construction.
2. Design aggregate gradation for construction of pavement layers keeping in mind the density and strength parameters.
3. Characterize the binder material for bituminous roads and provide an optimum bituminous mix design.
4. Provide mix design procedure and the base layer for a CC pavement.
5. Propose soil stabilization techniques for highway construction using locally available materials.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Problem Analysis.*
- *Usage of modern tools*
- *Ethical practices and social responsibility*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 12 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. S.K. Khanna, C.E.G Justo and A. Veeraragavan, "Highway Engineering"- Nem Chand and Bros., Roorkee. Revised 10th Edition.
2. Freddy L Roberts, Prithvi S Kandhal et al, "Hot Mix Asphalt Materials, mixture design and construction"- (2nd Edition), National Asphalt Pavement Association Research and Education Foundation, Maryland, USA
3. Prithvi Singh Kandhal, "Bituminous Road Construction in India", PHI Publications,2016, ISBN: 978-81-203-5258-2
4. "Bituminous materials in Road Construction"- HMSO Publication.

Reference Books:

1. MoRTH 'Specifications for Roads and Bridges Works'- Indian Roads Congress.
2. Relevant IRC/ASTM codes and specifications
3. Delatte N. J., Concrete Pavement Design, Construction and Performance, CRC Press, Taylor & Franscis Group, 2014.
4. Peter C. Taylor, Steven H. Kosmatka, Gerald F. Voigt, et al., Integrated Materials and Construction Practices for Concrete Pavement: A State of the practice Manual Report No. FHWA HIF-07 – 004, 2007. Available online at https://intrans.iastate.edu/app/uploads/2019/05/IMCP manual pdf, Accessed on March 17, 2020.
5. Neville, A.M., Properties of Concrete, Fifth edition, Pearson, 2012.
6. Mehta, P. K., and Monterio, P. J. M., Concrete: Microstructure, Properties and Materials, Mc Graw Hill, Fourth Edition, 2013.
7. Shin-Che Huang and Herve Di Benedetto., Advances in Asphalt Materials: Road and Pavement Construction, First edition, April 2015.
8. S. K. Khanna and C.E.G Justo., "Highway Materials Testing"- Nem Chand and Bros., Roorkee.
9. "Soil Mechanics for Road Engineers" - HMSO Publication.
10. Highway Hand Book ny FAW, Publication from NUS, Singapore.
11. Road and Pavement Construction, Shin-Che Huang Hervé Di Benedetto, Hardcover ISBN: 9780081002698, eBook ISBN: 9780081002711, Imprint: Woodhead Publishing, Published Date: 1st April, 2015, Page Count: 492

COURSE TITLE: PAVEMENT ANALYSIS AND DESIGN

[As per Choice Based Credit System (CBCS) scheme] SEMESTER – I

Subject Code	20 CHT13	CIE Marks	40
Number of Lecture Hours/Week	3:0:2	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the factors affecting pavement design and performance
2. Evaluate the strength of soil subgrade soil and factors that affect the behavior of soil.
3. Compute the stresses and deflections in flexible pavement layers under the action of wheel loads.
4. Design the thickness of flexible pavements by different methods under different exposure conditions and materials.
5. Design the thickness of concrete pavements and joints associated with CC pavements in addition to the computation of stresses in CC pavements.

Modules

Module -1

Pavements and pavement layers - types, functions, choice Factors affecting design of flexible, composite and rigid pavements – Pavement design factors, loads – axle load distribution, ESWL, EWL, VDF due to varying loads and CSA. Highway and Airfield Pavements

Module -2

Subgrade support - CBR and plate bearing tests, Resilient Modulus, fatigue tests, permanent deformation Pavement Material Characterization, climatic, drainage and environmental factors, their effects and evaluation. Factors affecting design and performance of airport pavements.

Module -3

Stresses and Deflection / strain in flexible pavements: Application of elastic theory, stresses, deflections / strains in single, two and three-layer and multi-layer system, Applications in pavement design. problems

Module -4

Flexible pavement design: Empirical, semi- empirical and theoretical design approaches, principle, advantages and application. Design steps by CBR method as per IRC, outline of other common design methods such as AASHTO and Asphalt
Institute methods, Problems.
Application of IIT PAVE software, ANSYS, KENPAVE, KENLAYER, AASHTOWARE

Module -5

Rigid pavement design: Determination of ESWL, EWL for dual and dual tandem wheel loads in Rigid pavements, General design principle, Stresses in rigid pavements, stresses due to wheel loads and temperature variations, design of cement concrete pavements (joints and slab thickness) as per IRC/PCA guidelines. Design features of CRCP, SFRC and ICBP, Problems.
Application of Design Software.

Course outcomes:

After studying this course, students will be able to:

1. Get the knowledge of factors affecting pavement design and performance
2. Evaluate the strength of soil subgrade soil and identify the factors that affect the behavior of soil.
3. Compute the stresses and deflections in flexible pavement layers under the action of wheel loads.
4. Design the thickness of flexible pavements by different methods under different exposure conditions and materials.
5. Design the thickness of concrete pavements and joints associated with CC pavements in addition to the computation of stresses in CC pavements.

Graduate Attributes (as per NBA)

- *Engineering Knowledge.*
- *Problem Analysis.*
- *Design / development of solutions (partly).*
- *Interpretation of data.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 12 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Yang H. Huang, "Pavement Analysis and Design", Second Edition, Pearson Education, 2008.
2. Rajib B. Mallick and Tahar EL-Korchi., "Pavement Engineering Principles and Practice", Third Edition, CRC Press Taylor and Francis Group.
3. Yoder, E. J. and Witczak, M. W., "Principles of Pavement Design", Second Edition, John Wiley and sons

Reference Books:

1. Huang, "Pavement Analysis"- Elsevier Publications
2. David Croney, Paul Croney, "Design & Performance of Road Pavements"- Mc Graw hill Book Co.
3. W.Ronald Hudson, Ralph Haas and Zeniswki "Modern Pavement Management"- Mc Graw Hill and Co.
4. S.K. Khanna, C.E.G Justo and A. Veeraragavan "Highway Engineering"- Nem Chand and Bros., Roorkee. Revised 10th Edition.
5. Relevant IRC Codes

COURSE TITLE: ROAD GEOMETRIC DESIGN

[As per Choice Based Credit System (CBCS) scheme] SEMESTER – I

Subject Code	20 CHT14	CIE Marks	40
Number of Lecture Hours/Week	3:0:2	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the Geometrical design elements.
2. Plan the geometric elements for varying conditions of roads.
3. Examine the geometric elements for highway geometric design.
4. Judge and propose the geometric element facilities for varying highway conditions

Modules

Module -1

Introduction: Importance, Factors governing geometric design, route selection, geometric design consistency, capacity of rural and urban roads.

Cross Section Elements: Right of way and width consideration, roadway, shoulders, Kerbs, traffic barriers, medians, service roads, pavement surface characteristics, cross slope, skid resistance, unevenness.

Module -2

Geometric Design Elements for inter-city highways and expressways **:** Sight Distances-SSD,ISD,OSD, factors governing sight distances, Design of horizontal alignment-overturning and skidding, super elevation, extra widening, transition curves, Design of vertical alignment,-gradient, vertical curves

Module -3

Intersection Design: At grade intersections- sight distance consideration and principles of design, Channelization, mini roundabout, roundabout, Inter-changes- major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes.

Module -4

Roadway facilities: Pedestrian facilities, bus bay, truck lay bays, frontage roads, parking areas, cattle crossings, lighting, toll plazas, and maintenance center, landscaping and tree plantation

Module -5

Geometric Design of Hill Roads: Classification, width of road land, roadway, carriageway, design speed, sight distances, horizontal alignment, vertical alignment, hairpin bends, passing places, lateral and vertical clearances.

Use of software: Mx Roads/ Open roads,/ Civil 3D

Course outcomes:

After studying this course, students will be able to:

1. Understand the Geometrical design elements.
2. Plan the geometric elements for varying conditions of roads.
3. Examine the geometric elements for highway geometric design.
4. Judge and propose the geometric element facilities for varying highway conditions.

G**raduate Attributes (as per NBA)**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 12 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Highway Engineering, S.K. Khanna, C.E.G Justo and A. Veeraragavan, Nem Chand and Bros., Roorkee. Revised 10th Edition, ISBN: 978-8185240930

2. A Policy on Geometric Design of Highways and Streets, (The Green Book) 7th Edition, American Association of State Highway and Transportation Officials (AASHTO) Publishers, 2018, ISBN Number: 978-1-56051-676-7

3. Geometric Design Projects for Highways: An Introduction, John G Schoon, 2nd Edition, American Society of Civil Engineers Press, ISBN:978-0-7844-7042-8, 2000

4. Relevant Indian Road Congress Code Books (IRC)

COURSE TITLE: TRAFFIC ENGINEERING AND MANAGEMENT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	20CHT15	CIE Marks	40
Number of Lecture Hours/Week	3:0:2	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Analyse the factors affecting performance of road traffic and the various traffic studies needed for the analysis of traffic flow.
2. Evaluate level of service and capacity of roadways and intersections using traffic data.
3. Propose and design suitable traffic regulatory system based on traffic requirements such as signs, signals, markings, etc.
4. Analyse and design intersections at-grade and grade separated types for smooth and safe movement of vehicles.
5. Propose parking facilities, pedestrian facilities and general safety measures required for highways and expressways.

Modules

Module -1

Traffic Studies & Analysis: Scope, traffic elements - Characteristics-vehicle, road user :and road - Traffic studies-speed & delay, traffic volume, O & D, parking and accidents - Sample size, study methodology - Data analysis & inferences.

Module -2

Traffic Flow Analysis: Macroscopic, Microscopic & Mesoscopic approach – Types of Flow- Traffic stream characteristics – Space – Time diagram – Relationship between speed, flow & density-Level of service & capacity analysis – Shockwave theory.

Module -3

Intersection Design: Types of intersections - Conflict diagrams –Control hierarchy- Design of rotaries & at-grade intersections – Signal design - Grade separated intersections & their warrants.

Module -4

Geometric Design : Cross sections – Sight distances – Super elevation – Horizontal & vertical alignments – Safety considerations

Road Safety Audit : Global & Local perspective – Road safety issues – Road safety programmes – Types of RSA, planning, design, construction & operation stage audits – Methodology – Road safety audit measures

Module -5

Traffic Regulation & Traffic Safety Management : Speed, vehicle, parking, enforcement regulations - Mixed traffic regulation - Management techniques, one-way, tidal flow, turning restrictions etc. – Transportation System Management Process – TSM planning & Strategies

Use of software: PTV VISSIM / VISUM (Traffic Flow Simulations), SIDRA (intersections), etc.

Course outcomes:

After studying this course, students will be able to:

1. Gets the knowledge of factors affecting performance of road traffic and also the traffic studies needed for the analysis.
2. Evaluate level of service and capacity of roadways and intersections.
3. Propose and design suitable traffic regulatory system such as signs, signals, markings, etc.
4. Analyse and design intersections at-grade and grade separated types for smooth and safe movement of vehicles.
5. Propose parking facilities, pedestrian facilities and general safety measures required for highways and Expressways.

Graduate Attributes (as per NBA)

- *Engineering Knowledge.*
- *Problem Analysis.*
- *Critical thinking*
- *Interpretation of data.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 12 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Kadiyali L.R. "Traffic Engineering and Transportation Planning"-Khanna Publication, New Delhi
2. Nicholas J.Garber, Lester A. Hoel, "Traffic and Highway Engineering", Third Edition Thompson Learning

Reference Books

1. Salter RJ and Hounsell NB, "Highway, Traffic Analysis and Design"- Macmillan Press Ltd., London.
2. Matson T M, Smith W S , Hurd F W, " Traffic Engineering, Mc graw Hill Book Co, NY , USA.
3. Drew D R ," Traffic Flow Theory and Control", McGraw Hill Book Co, NY, USA.
4. Wohl and Martin, "Traffic System Analysis of Engineers and Planners"-Mcgraw Hill Book Co, New York, USA.
5. May, A.D., *Traffic Flow Fundamentals*, Prentice – Hall, Inc., New Jersey,1990.
6. O'Flaherty C A, *Highways- Traffic Planning & Engineering*, Edward Arnold, UK
7. Pignataro , " Traffic Engineering", John wiley & sons. Nicholas J Garber, Lester A Hoel, "Traffic & Highway Engineering"- Third edition,
8. IRC: SP 43 1994 and other Relevant IRC codes
9. S.K. Khanna, C.E.G Justo and A. Veeraragavan, "Highway Engineering"- Nem Chand and Bros., Roorkee. Revised 10th Edition.
10. Indian Highway Capacity Manual (Indo-HCM) CSIR, New Delhi, 2012-2017

COURSE TITLE: PAVEMENT ENGINEERING LAB -I

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	20CHTL16	CIE Marks	40
Practical /field work/Assignment	0:4:0	SEE Marks	60
Credits	2	Exam Hours	03

CREDITS – 02

Course objectives: The objective of this course is to make students learn

- The procedure and test the basic properties of soil, aggregates, cement and concrete

Modules

Tests on soil

1. Grain size analysis - Wet sieve analysis
2. Liquid limit, plastic limit & Shrinkage limit
3. Compaction test
4. California bearing ratio test and Determination of Effective CBR
5. Unconfined Compression Strength Test
6. Field density by sand replacement & Core cutter method

Tests on aggregates

1. Shape tests - Elongation, Flakiness Index & Combined Index, Angularity Number
2. Aggregate impact value test
3. Los Angeles abrasion value test
4. Specific gravity & Water absorption test
5. Stripping value test

Tests on cement & concrete

1. Fineness of Cement
2. Standard consistency & setting time of cement
3. Soundness
4. Compressive strength
5. Concrete Mix design
6. Compressive Strength
7. Flexural strength

Traffic Studies and analysis

1. Traffic Volume Count at Mid-Block Section
2. Turning Movement Count at an Intersection
3. Registration Number Plate Survey
4. Spot Speed Survey
5. Speed and Delay Study by Moving Observer Method
6. Video graphic studies
7. Origin and Destination Study- Road Side Questionnaire Survey
8. Parking Inventory & Usage Survey by Patrol
9. Road safety audit: Construction & Operation stage

Course outcomes:

After the completion of the course students should have

- Acquired the expertise to conduct various tests on soil, aggregates, cement and concrete
- Acquired the expertise to conduct various traffic surveys in the field, analyze and interpret the data collected.

Text Books:

1. Khanna, S.K., Justo, C.E.G., and A.Veeraragavan , `Highway Materials and Pavement Testing', Nem Chand and Bros, Roorkee
2. Gambhir, M. L., 'Concrete Manual', Dhanpat Rai and sons New Delhi
3. Kadiyali L.R. "Traffic Engineering and Transportation Planning"-Khanna Publication, New Delhi

Reference Books:

1. Relevant IS and IRC codes

Course Title: RESEARCH METHODOLOGY AND IPR [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	20RMI17	CIE Marks	40
Number of Lecture Hours/Week	2:0:0	SEE Marks	60
Credits	2	Exam Hours	03
Course objectives:			
Modules - Common to all branches (As per VTU guidelines)			
Module 1			
Module 2			
Module 3			
Module 4			
Module 5			
Course outcomes:			
Graduate Attributes (as per NBA)			
Question paper pattern:			
Text Books: **Reference Books:**			

COURSE TITLE: HIGHWAY CONSTRUCTION TECHNOLOGY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	20CHT21	CIE Marks	40
Number of Lecture Hours/Week	3:0:2	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the various equipment used for road construction and difficulties associated with highway drainage.
2. Select suitable equipment for preparation of subgrade in cutting or filling and also the preparation steps for base and sub base layers.
3. Characteristics of different types of bituminous layers and design of bituminous surfacing along with safety aspects needed for roads.
4. Design the base course thickness and selection of materials as base layer for CC pavements.
5. Analyse the defects in road construction and general pavement failures with remedies.

Modules

Module -1

Plants and Equipment: Components of pavement structure, functions and requirements,
Plants and equipment: Excavators, graders, compactors, crushers, bituminous hot mix plants, cement concrete mixers, pavers - uses in road construction.

Module -2

Construction of Subgrade and Subbase: Specifications and steps for construction of subgrade, subbase, quality control tests

Construction of granular layers: Specifications and steps of construction, WBM, WMM, CRM, quality control tests

Construction of Bituminous Layers: Different types of bituminous layers, specifications and construction of bituminous layers, quality control tests

Module -3

Construction of Cement Concrete Pavements: Specifications and steps for construction of DLC, Paving Quality Concrete pavements, quality control tests
Specifications and steps for construction of White topping, Interlocking concrete block pavements, quality control tests. **Safety during Construction**: Safety aspects during construction and maintenance works, road safety furniture.

Module -4

Drainage: Assessment of drainage requirements for the road, design of various drainage components, drainage materials, surface and sub-surface drainage system for roads, drainage of urban roads.

Module -5

Maintenance and Rehabilitation of bituminous and concrete pavements: Routine and periodic maintenance, preventive and reactive maintenance for drainage and pavements, Preparation of existing pavement for patching, profile correction, special measures to deal with reflection cracks in pavement overlays, requirements for rehabilitation, recycling.
Recycling of pavements- cold recycling, hot recycling, Full Depth Reclamation, road construction in water logged areas, design and construction of RE walls to be added.

Course outcomes:

After studying this course, students will be able to:

1. Gain the knowledge on the equipment used for road construction and difficulties associated with highway drainage.
2. Select suitable equipment for preparation of subgrade and preparation stages for base and sub base layers.
3. Design bituminous surfacing and other layers along with safety aspects needed during construction.
4. Design the base course thickness and select materials for base layer in CC pavements.
5. Analyze the defects in road construction and general pavement failures and propose suitable remedies.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Critical thinking.*
- *Ethical practices and social responsibility*
- *Use of modern tools*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 12 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. "Highway Engineering", Khanna and CEG Justo, A. Veeraragavan, Revised 10th edition, published by Nem Chand & Bros, Roorkee, ISBN:978-81-85240-80-0
2. Prithvi Singh Kandhal, "Bituminous Road Construction in India", ISBN: 978- 8120352582
3. Delatte N. J., Concrete Pavement Design, Construction, and Performance, CRC Press, Taylor & Francis Group, 2014

Reference Books:

1. MoRTH "Specifications for Roads and Bridge Works"- 2013 Fifth revision, Indian Roads Congress
2. MoRTH "Manual for Construction and Supervision of Bituminous Works"- 2001, Indian Roads Congress
3. MoRTH "Manual for Maintenance of Roads"- 1989, Indian Roads Congress
4. "Pavement Drainage- Theory and Practice", G.L. Shivakumar Babu, Prithvi S Kandhal, Nivedya Mandankara Kottayi, Rajib Mallick, A. Veeraragavan
5. Freddy L Roberts, Prithvi S Kandhal et al, "Hot Mix Asphalt Materials, mixture design and construction"- (2nd Edition), National Asphalt Pavement Association Research and Education Foundation, Maryland, USA
6. National Asphalt Pavement Association "Hot Mix Asphalt Paving Hand book"- 5100 Forbes Boulevard, Lanhm, Mary Land, USA
7. "Hand Book on Cement Concrete Roads"- Cement Manufacturers Association, New Delhi
8. Relevant IRC Codes

Course Title: DETAILED PROJECT REPORT PREPARATION

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	20CHT22	CIE Marks	40
Number of Lecture Hours/Week	3:0:2	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives:

This course will enable students to

1. Prepare project report for new and up-gradation type road works by conducting necessary feasibility/detailed studies.
2. Conduct the soil and material investigations to understand their behavior and performance.
3. Perform various traffic related studies helping to finalize the project preparations and methods of forecasting traffic data.
4. Analyse the social impact of road projects and also determine the economic feasibility analysis for justification of investments.
5. Prepare DPR on road projects with relevant drawings and get the knowledge of tendering process for the construction.

Modules

Module -1

Introduction: Various steps of preparation and execution of road projects, Investigations for preparation of project reports for new and up-gradation of roads. Objects and scope of pre – feasibility, feasibility and detailed studies for project preparation. Typical HR structure for preparations and implementation of road projects, Key Acts related to Road Projects. Salient features of ongoing road projects in India.

Module -2

Topographic surveys and investigations for finalization of horizontal alignment and vertical profile of roads, Application of GIS. Soil and other Material surveys and investigations for availability and choice of basic and alternate materials for road construction and for soil stabilization. Cross drainage structures and drainage surveys, Interpretation of survey results.

Traffic Surveys and Traffic forecasting: classified traffic volume, growth rate, projected traffic for assessing road way requirements, origin- destination characteristics and studies, Axle load / wheel load studies using weigh bridges and analysis of data for pavement design

Module -3

Geometric Design and General elements: Geometrical elements of rural and urban roads Cross sectional elements, horizontal and vertical alignment, Intersections-requirements, capacity of roads, road way facilities: Pedestrian facilities, bus bays, truck lay byes, traffic, medical and vehicle aid posts, street lighting, road safety audit, road safety furniture, Mx ROAD

Module -4

Environmental Impact Assessment: Objectives, procedure of environmental impact assessment, socio economic survey, mitigation measures, Landscaping and tree plantation, implementation of environment management plan, Key environmental legislations, clearances required for road project- environmental, forest, CRZ, wild life, air, noise quality standards

Module -5

Preparation of DPR design details, estimates, BOQ, drawings and detailed project, report, use of software, **Tendering process** - Preparation of tender documents for different types of road projects, Tender evaluation. Salient clauses of tender document, tender evaluation – technical and Financial.

Course outcomes:

After studying this course, students will be able to:

1. Prepare project report for new and up-gradation type road works by conducting necessary Feasibility/detailed studies.
2. Conduct the soil and material investigations to understand their behaviour and performance.
3. Analyze the surveys and investigations and select geometry of road
4. Understand the contract document, evaluation and contract management for road projects Analyse the social impact of road projects and also determine the economic feasibility analysis for justification of Investments.
5. Prepare DPR on road projects with relevant drawings and get the knowledge of tendering process for the Construction. .

Graduate Attributes (as per NBA)

- *Engineering Knowledge.*
- *Problem Analysis.*
- *Design / development of solutions (partly).*
- *Interpretation of data.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. L.R.Kadyali, N.B.Lal, "Principles and Practices of Highway Engineering,, Khanna Publishers

Reference Books:

1. IRC: SP:19 - 2001, Manual for Survey, "Investigation and Preparation of Road Projects"- (first revision), Indian Roads Congress
2. IRC: SP: 30 - 1993, "Manual on Economic Evaluation of Highway"- Projects in India (first revision), Indian Roads Congress
3. IRC SP – 38,"Manual for Road Investment Decision Model"-1992, Indian Roads Congress
4. IRC : 9-1972, 35 – 1997,38-1988, 39-1986, 52-2001, 54-974, 62-1976, 64-1990, 66-1976, 67-2001, 69-1977, 73-1980, 79-1981, 80-1981, 86-1983, 98-1997, 99-1988, 103-1988, 104-1988, 110-1996
5. MoRTH "Specifications for Road Bridge Works"- 2001, fourth revision, Indian Roads Congress
6. MoRTH "Standard and Bidding Document Procurement of Civil Works"- Part I and II, 2000, Indian Roads Congress MoRTH "Model Concession Agreement for Small Road Projects"-2000, Indian Roads Congress

Course Title: PAVEMENT MANAGEMENT SYSTEM
[As per Choice Based Credit System (CBCS) scheme]
Semester -II

Subject Code	20CHT23	CIE Marks	40
Number of Lecture Hours/Week	3:0:2	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 03

Course objectives:
To make students learn evaluation and prediction of pavement performance, to learn Ranking and economic optimization of pavement maintenance and rehabilitation and management.

Modules

Module -1

Introduction: Components & principals of pavement management systems, pavement maintenance measures, planning investment, research management. Pavement Management Data Needs, Inventory Data Needs

Characterizing Pavement performance: Serviceability Performance concept, Pavement Roughness, Equipment for evaluating roughness, Universal roughness standard, Calibration needs, relating roughness to serviceability, Applications of Roughness data

Evaluation of Pavement Structural Capacity - Nondestructive measurement and analysis, Destructive structural evaluation, Structural Capacity Index concepts, Network versus Project level applications of structural capacity evaluation

Module -2

Evaluation of Pavement Surface distress condition surveys – purpose, methods- manual and automated, types of distress, distress survey procedures, equipment used

Evaluation of Pavement Safety: skid resistance evaluation - basic concepts , importance of surface texture, methods of measuring skid resistance, friction management in Pavement Management, Combined measures of Pavement Quality, Data Base Management, **Present status of Pavement networks -** Performance measures, Strategic level pavement management, state of road network in terms of IRI, in terms of Asset value.

Module -3

Determining Present and future needs and priority programming of rehabilitation and maintenance – Establishing criteria, prediction models for pavement deterioration, determining needs, Rehabilitation & Maintenance alternatives and priority programming, **Structural design and economic analysis –** MEPDG process for pavement design, Economic evaluation of alternative pavement design strategies and selection of optimal strategy, Implementation of pavement management system.

Module -4

Design alternatives and Selection: Design objectives and constraints, basic structural response models, physical design inputs, alternate pavement design strategies and economic evaluation, reliability concepts in pavement engineering, life cycles costing, analysis of alternate pavement strategies based on distress and performance, case studies and Problems.

Module -5

Expert systems and Pavement Management: Role of computers in pavement management, applications of expert systems for managing pavements, expert system for pavement evaluation and rehabilitation, knowledge – based expert systems, case studies. Implementation of Pavement Management Systems.

Use of softwares: HDM-4/dTIMS.

Course outcomes:
On completion of this course, Students would be able to design alternate pavement management systems based on life cycle cost analysis.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Problem solving.*
- *Usage of modern tools*
- *Interpretation of data.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 12 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Ralph Hass, W.Ronald Hudson with Lyne Cowe Falls., "Pavement Asset Management"-Scrivner Publisher, copyright 2015
2. Ralph Hass, W. Ronald Hudson. W. R., Zaniewisti .J. "Modern Pavement Management" – Krieger Publishing Company, Florida, 1994.

Reference Books:

1. Proceedings of North American Conference on Managing Pavement.
2. Proceedings of International Conference on Structural Design of Asphalt Pavements.
3. NCHRP, TRR and TRB Special Reports.
4. Freddy L Roberts, Prithvi S Kandhal et al, "Hot Mix Asphalt Materials, mixture design and construction"- (2nd Edition), National Asphalt Pavement Association Research and Education Foundation, Maryland, USA.
5. Highway Hand Book by FAW, Publication from NUS, Singapore.
6. Nicholas J.Garber, Lester A. Hoel, "Traffic and Highway Engineering", Third Edition Thompson Learning
7. IRC 81, 1997, GUIDELINES FOR STRENGTHENING OF FLEXIBLE ROAD PAVEMENTS USING BENKELMAN BEAM DEFLECTION TECHNIQUE
8. IRC SP 16, 2004 Guidelines for Surface Evenness of Highway Pavements

COURSE TITLE: CONSTRUCTION EQUIPMENT AND SAFETY MANAGEMENT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	20CHT241/20CIM241	CIE Marks	40
Number of Lecture Hours/Week	4:0:0	SEE Marks	60
Credits	4	Exam Hours	03

Course objectives:

This course will enable students to

- Understand the importance of safety in construction industry.
- Understand different types of equipment used in construction and its economic consideration.

Modules

Module 1

Plants and Equipment for production of materials: Crushers, mixers, bituminous mixing plants, concrete mixing plants, advantages, choice.

Module 2

Construction Equipment: Operations, applications and performance of dozers, excavators, graders, compactors, pavers, haulers, crawler, wheel tractors, power shovels, Cranes, hauling equipment's

Module 3

Selection of Construction Equipment: Task considerations, cost considerations, engineering considerations, equipment acquisition options, Maintenance of Equipment: Repairs, log maintenance, safety during operation, economical life of equipment

Module 4

Safety in Use of Construction equipment's: Human Factors in Construction Safety management Motivation: Management, Supervisors, Workers, Motivational schemes

Module 5:

Safety Management: Role of first line supervisors, Role of middle managers, Role of workers, top management practices, safety audit, Safety in site preparation, Design, safety culture, Top Management, Company Activities and Safety - Safety Personnel, Sub-contractual Obligation - Project Coordination and Safety Procedures

Course outcomes:

After studying this course, students will be able to:

- Identify and understand use of equipment and its benefits.
- Understand necessity of safety management.
- Identify importance of safety with respect to Client, contractor and sub-contractors.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Problem Analysis.*
- *Design / development of solutions (partly).*
- *Ethical practices and social responsibility*

Text Books:

1. Peurifoy, R.L., Ledbette. W.B., Construction Planning, Equipment and Methods, McGraw Hill Co.,
2. Antil J.M., Civil Engineering Construction, McGraw Hill Book Co.
3. K.K. Chitkara. "Construction Project Management Planning, Scheduling and Controlling"- Tata McGraw Hill publications
4. S.C. Sharma "Construction Equipment and its Management"- Khanna Publishers

Reference Books:

1. IRC "A Manual for the Application of Critical Path Method to Highway Projects in India"
2. Nhai.org, pmgsy.nic.in websites
3. Hand Book on Construction Safety Practices, SP 70, BIS 2001.
4. Jimmy W. Hinze, Construction Safety, Prentice Hall Inc., 1997
5. Richard J. Coble, Jimmie Hinze and Theo C. Haupt, Construction Safety and Health

Course Title: DESIGN OF BRIDGE AND GRADE SEPARATED STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	20CHT242	CIE Marks	40
Number of Lecture Hours/Week	4:0:0	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the types and components of a bridge with specifications for designing them for highways.
2. Understand the use of different types of bridge bearings, their installation and maintenance aspects under the action of vehicular loads.
3. Understand the design aspects of bridge approaches for RCC, PSC and Steel bridges.
4. Analyse the loading conditions on the bridges and design the elements as per IRC load specifications.
5. Understand the quality control measures during the execution of bridges both for substructure and super structure portions of the bridge.

Modules

Module -1

Introduction to Bridges: Basic Elements of a Bridge.
Types of bridges and grade separated structures for highways, standard Specifications for road bridges and grade separated structures to fulfill traffic and Structural and Hydraulic design requirements.

Module -2

Bridge bearings- joints, approaches, construction and maintenance aspects.

Module -3

Basic design approaches of RCC, PSC and steel bridges superstructure. Types of bridges for IRC loading conditions

Module -4

General Design Considerations for grade separated structures and their choices, IRC Class AA Tracked and Wheeled Loading Analysis, Problems.

Module -5

Introduction to Construction Specification and quality control: for foundations and substructures of bridges and Grade separated Interchanges – Types, warrants and Design standards. Concept of evaluation of existing bridge structures. Methods of rehabilitation and widening.

Course outcomes:

After studying this course, students will be able to:

1. Design the components of a bridge following the specifications for highways.
2. Get the knowledge of bridge bearings, their installation and maintenance aspects to withstand vehicular loads.
3. Understand the design aspects of bridge approaches for RCC, PSC and Steel bridges.
4. Analyse the IRC loading conditions for the design of bridges.
5. Understand the quality control measures during the execution of bridges both for substructure and super structure portions of the bridge.

Graduate Attributes

- *Critical thinking*
- *Problem solving.*
- *Collaborative and multidisciplinary work*
- *Interpretation of data.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 12 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. D.Johnson Victor, "Essentials of bridge Engineering"- Oxford, IBH publishing company.
2. Ponnuswamy, "Bridge Engineering"-McGraw Hill Publication, 1989.

Reference Books:

1. Relevant IRC codes
2. Vazirani Ratwani & M.G.Aswani, "Design of Concrete Bridges"- Khanna Publishers, New Delhi
3. "Design of Bridges"- Dr. Krishna Raju, Oxford & IBH Publishing Company Limited.
4. "Analysis and design of Bridges"- M.A.Jayaram, Sapna Publishers, Bangalore.

Course Title: GROUND IMPROVEMENT TECHNIQUES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	20CHT243/20CIM243	CIE Marks	40
Number of Lecture Hours/Week	4:0:0	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives:

This course will enable students to:

- Introduce the various types of improvement methods of engineering properties soils
- Introduce the application of engineering methods to ground improvement projects
- Basic knowledge on various 323 and their suitability for various types of soil conditions
- The skills of implementation of geotechnical knowledge in field situations

Modules

Module -1

Introduction - Need and objectives of ground improvement, classification of ground modification techniques, trends in ground improvement, Engineering properties of soft, weak and compressible deposits; Principles of treatment; **Methods of compaction:** Blasting, dynamic consolidation, pre-compression and compaction piles.

Module -2

Methods of dewatering: Open sumps and ditches, well point system, electro- osmosis, Vacuum dewatering wells; pre-loading without and with sand drains, strip drains and rope drains.

Stabilization: With admixtures like cement, lime, calcium chloride, fly ash and bitumen. Methods of soil improvement-lime stabilization and injection; thermal, electrical and chemical methods.

Module -3

Soil reinforcement: Reinforcing materials, concept of confinement, Gabbion walls; Dynamic consolidation, Vibro flotation, Pre-consolidation with vertical drains, Granular piles, Soil nailing, Anchors & Thermal methods.

Module -4

Improvement of Foundation Soils

(a) Improvement of granular soils: Terms used to describe degree of compactness – relative density, density ratio and degree of compaction; Methods-Vibration at ground surface, factors influencing roller compaction; deep dynamic compaction, vibro- compaction impact at depth.

Improvement of cohesive soils: Preloading, or dewatering, methods of installing: sand drains, drain wicks, electrical and thermal methods.

Module -5

Grouting: Materials of grouting, grouting techniques and control; purpose, functions, types of grouts; soil bentonite - cement mix; Emulsions & solutions; grout injection methods; Geo-synthetics: types, functions & Classification of geo-textiles. Specific Applications: Bearing capacity improvement, reinforcement, Retaining walls, embankment etc.

Course outcomes:

After studying this course, students will be able to:

1. Analyse the need for ground improvement in weak and soft soils with likely modifications to improve their performance.
2. Decide on suitable dewatering method in soils to improve their performance as highway material.
3. Apply appropriate soil strengthening techniques by stabilisation using either by lime, cement, flyash or bitumen.
4. Evaluate the strengthening techniques by reinforcing bars or anchoring methods depending on the type of soil.
5. Use ground improvement techniques such as geo-synthetics or grouting for cohesive soils.

Graduate Attributes

- *Scholarship of Knowledge.*
- *Problem Analysis.*
- *Critical thinking*
- *Interpretation of data.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 12 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Manfred R. Hansmann - Engineering principles of ground modification - Me. Graw-Hill pub. Co., NewYork.
2. Robert M. Koerner - Construction and Geotechnical methods in Foundation Engineering - MC.Graw-Hill Pub. Co., New York.

Reference Books:

1. Winterkorn and Fang - Foundation Engineering Hand Book - Van Nostrand Reinhold Co.,New York.
2. Aris C. Stamatopoulos & Panaghiotis C. Kotzios - Soil Improvement by Preloading – John Wiley & Sons Inc. Canada.
3. P. Purushothama Rao - Ground Improvement Techniques - Laxmi Publications.

Course Title: SOIL MECHANICS FOR PAVEMENT ENGINEERS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	20CHT244/20CIM244	CIE Marks	40
Number of Lecture Hours/Week	4:0:0	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the properties and behavior as a highway material under the application of wheel loads.
2. Understand and compare the shear strength of soil and stability of slopes when used as subgrade soil and embankment fills or cut slopes
3. Understand the permeability characteristics of soils to design proper drainage system and various investigations required to assess the soil properties.
4. Understand the type and soil composition affecting the surface runoff and sub-surface water flow in order to design proper drainage system.
5. Analyse lack of strength or instability problems in soils due to soil formation or any other reasons and propose suitable strengthening methods for the same.

Modules

Module -1

Introduction: Soil Mechanics applications to Highway / Infrastructure Engineering. Soil formations, Types, Regional Soil deposits of India, Index properties, their determination, importance, various soil classification systems, HRB classification, problems on these.

Soil Compaction: Introduction, Lab Tests, Factors affecting, Structure & Engineering behavior of compacted cohesive soil, Field compaction specifications, Field compaction control, Different types of Equipment used for compaction, their choice.

Module -2

Shear strength of soil: Introduction, Importance, Measurements, shear strength of clay, Sand, Elastic properties of soil – Tangent, Secant modulus, Stress – Strain curves, Poisson's ratio, Shear Modulus.

Stability of slopes: Introduction, Types, Different methods of analysis of slopes for Øu+0 & C-Ø soil, Location of most critical circle, Earth dam slopes stability, Taylor's stability number. Effect of Earthquake Force, problems on above.

Module -3

Permeability of soil: Darcy's Law, Validity, Soil-water system, Types, Determination of permeability, problems.

Site Investigation: Introduction, Planning exploration programmes, Methods, Samplers, SPT, Subsoil investigation Report, Geophysical methods.

Module -4

Special attention for subgrade condition: Problematic soils, compressible &collapsible soils, swelling, subsurface water, frost-susceptible soils.

Surface drainage, Sub-surface drainage, methods, Design of subsurface drainage system, soil stabilization, soil encapsulation. Base layer requirement-erodibility of bases, bound bases, modified or treated bases, base reinforcement

Highway Drainage: Introduction, Importance, Surface drainage, Sub-surface drainage, methods, Design of subsurface drainage system, Road construction in water logged areas, Landslides – definition, classifies, factors producing.

Module -5

Reinforced Earth structures Introduction, Components, Advantages, Types of stability – external, Internal, (No problems), Geo textiles – types, Functions, their uses in road embankments and railway works, other uses. Landslides – definition, classifies, factors producing.

Course outcomes:

After studying this course, students will be able to:

1. Analyse the wheel load effects on pavement materials
2. Evaluate and compare the shear strength of soil and stability of slopes when used as pavement component.
3. Design proper drainage system by knowing the permeability characteristics of soils.
4. Design surface runoff and sub-surface drainage system as per field conditions
5. Propose suitable strengthening methods for soil from the knowledge of lack of strength or instability in soils.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Problem Analysis.*
- *Design / development of solutions (partly).*
- *Interpretation of data.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 12 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. "Basic and Applied soil Mechanics", Gopal Ranjan, ASR Rao, New Age International Publishers.
2. "Soil Mechanics & Foundation Engg", Dr.B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Laxmi Publications (P) Ltd, 16th edition.
3. S.K. Khanna, C.E.G Justo and A. Veeraragavan, "Highway Engineering"- Nem Chand and Bros., Roorkee. Revised 10th Edition.

Reference Books:

1. "Geotechnical aspects of pavement reference manual", US department of transportation, Publication no: FHWA NHI-05-037, Federal Highway Administration, May 2006, NHI course no:132040
2. "Soil Mechanics & Foundation Engg" – K.R. Arora Standard Publishers Distributors.
3. "Soil Mechanics for road Engineers" – HMSO, London.
4. IRC – Relevant Codes.

Course Title: SPECIAL CONCRETE

[As per Choice Based Credit System (CBCS) scheme]

Semester -II

Subject Code	20CHT251	CIE Marks	40
Number of Lecture Hours/Week	4:0:0	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. To understand the factors affecting pavement design and performance of Rural Roads.
2. To relate the concepts of Highway Geometric design to that of Rural roads
3. To design the Special pavements which form alternatives for Rural Roads.
4. To understand the concepts of design of drainage, CD works and small bridges which form essential structures of Rural roads

Modules

Module -1

Brief Review of Conventional Concrete and Constituent Materials: Different types of blended cement & their salient properties, including cement binding materials (fly ash, condensed silica fumes, GGBS and other fine fillers), concrete aggregates- classification, Salient features of concrete mix design as per Indian standard (IS:10262:2009).

Module -2

Light Weight and High Density Concrete: Definition, Proportioning, Properties and Applications.

Pumped concrete: Introduction, Types of concrete pump, Requirements of a concrete for pumping, Effects of aggregates, cement and admixtures on the pumpability of concrete, Workability of Pumpable of Concrete - Rheology of Concrete- Introduction, measuring the rheological parameters and techniques.

Module -3

Self-compacting concrete: Introduction, Materials, Mix design of SCC, Fresh and Hardened Properties of SCC.

Geo-polymer Concrete: Brief history of development, Definition, Reaction chemistry, material characterization, mix proportioning, properties and applications

Module -4

Fiber-reinforced Concrete: Brief Introduction on FRC, Mix design of FRC, Behaviour of hardened FRC under compression, tension flexure and impact, SIFCON, Ductal Concrete.

Concrete Fracture Mechanics - Brief introduction, Fracture Mechanics in Concrete - Concept.

Module -5

Recycled concrete: Introduction, properties of recycled aggregate, Methods of recycling and quality, Applications.

Waste Materials in Concrete: Introduction, waste material, waste glass, waste plastic and waste rubber. Brief introduction on low strength mortars and its applications.

Course outcomes:

After studying this course, students will be able to:

1. Identify ingredient of concrete material characteristics and different types of concrete for their appropriate use in construction.
2. Design special concrete mixes like Self-compacted concrete and Geo-polymer
3. Concrete mixes and asses the fresh and hardened properties using various guidelines.
4. Determine the compressive strength of concrete structures by Non Destructive Methods.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Problem Analysis.*
- *Design / development of solutions (partly).*
- *Ethical practices and social responsibility.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. A. M. Neville, Properties of Concrete, Pearson Education (Singapore) Pvt. Ltd.
2. P. Kumar Mehta and Paulo J. M. Monteiro, "Concrete Microstructure, Properties, and Materials"- McGraw Hill Education

References:

1. John Newman and Ban Seng Choo, Advanced Concrete Technology, ISBN 0 7506 5105 9, Elsevier Ltd.
2. Concrete Construction Engineering Handbook by Dr. Edward G. Nawy, CPC Press, 2nd Edition, ISBN 9780849374920.
3. Joseph A. Daczko, Self-Compacted Concrete by-Applying what we know, CPC Press, ISBN-13: 978-0-203-84422-9

Course Title: ROAD SAFETY ENGINEERING AND MANAGEMENT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	20CHT252	CIE Marks	40
Number of Lecture Hours/week Total	4:0:0	Exam Marks	60
Credits	4	Exam Hour	03

CREDITS – 04

Course objectives: This course will enable students to

1. Analyze the effect of driver characteristics, roadway characteristics, and climatic factors on highway safety.
2. Plan and design a road safety improvement program.
3. Analyze accident data and suggest safety measures.
4. Conduct road safety audit.
5. Interpret accident data using statistical analysis.

Modules

Module 1

Highway Safety in India: traffic crashes on Indian highways, traffic on national highways and state highways, safety on national highways.

Introduction to safety: Road accidents, Trends, causes, Collision and Condition diagrams, Highway safety, human factors, Vehicle factors Road Safety Management System: Multi-causal dynamic systems approach to safety, crash vs accident, road safety improvement strategies, elements of a road safety plan, Safety Data Needs.

Module 2

Statistical Interpretation and Analysis of Crash Data: Before-after methods in crash analysis, Advanced statistical methods, Black Spot Identification & Investigations, Case Studies. Urban Safety and Mobility, Traffic Calming.

Module 3

Road Safety Audits: Key elements of a road safety audit, Road Safety Audits & Investigations, Crash investigation and analysis, Describe methods for identifying hazardous road locations, Vulnerable Road Users, Case Studies.

Module 4

Crash Reconstruction: Describe the basic information that can be obtained from the roadway surface, Understand basic physics related to crash reconstruction, speed for various skid, friction, drag, and acceleration scenarios, variables involved in jump and flip crashes, variables involved in pedestrian crashes, Case Studies.

Module 5

Mitigation Measures: Accident prevention by better planning, Accident prevention by better design of roads, Crash Countermeasures, Highway operation and accident control measures, Highway Safety Measures during construction, Highway geometry and safety.

Road safety management, road safety policy-making, stakeholders involved, developing the road safety management system, capacity building.

Course outcomes:

After studying this course, students will be able to:

1. Analyze the effect of driver characteristics, roadway characteristics, and climatic factors on highway safety.
2. Plan and design a road safety improvement program.
3. Analyze accident data and suggest safety measures.
4. Conduct road safety audit.
5. Interpret accident data using statistical analysis.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Critical thinking.*
- *Ethical practices and social responsibility*
- *Use of modern tools.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. V.F. Babkov "Road Conditions and Traffic Safety", Mir Publishers.
2. Pignataro , " Traffic Engineering", John wiley & sons.
3. Nicholas J Garber, Lester A Hoel, "Traffic & Highway Engineering"- Third edition, Thompson Learning
4. Ogden, K.W. Safer Roads: A Guide to Road Safety Engineering. Avebury Technical, 1996.
5. Martin Belcher, Steve Proctor and Phil Cook, Practical Road Safety Auditing, Third edition, ICE Publications, 2015
6. Gitam Tiwari, Dinesh Mohan, " Transport Planning and Traffic Safety-making cities, roads & vehicles safer", Published by CRC Press, ISBN-9781498751452

Reference Books:

1. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997
2. (reprinted 2002)
3. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.
4. J. Stannard Baker, Traffic Collision Investigation, Northwestern University Center for Public Safety, 2002.
5. Leonard Evans, Traffic Safety, Science Serving Society, 2004.
6. Lynn B. Fricke, Traffic Accident Reconstruction, Northwestern University Center for Public Safety, 1990.
7. Popkess C.A, Traffic Control and Road Accident Prevention, Chapman and Hall, 1997
8. Rune Elvik and Truls Vaa,, The Handbook of Road Safety Measures, Elsevier, 2004.
9. Simon Washington, Matthew Karlaftis, and Fred Mannering, Statistical and Econometric Methods for Transportation Data Analysis, Chapman & Hall/CRC Press, 2003.
10. Towards Safe Roads in Developing country, TRL – ODA, 2004.
11. https://www.icevirtuallibrary.com/isbn/9780727760166
12. https://www.routledge.com/Transport-Planning-and-Traffic-Safety-Making-Cities-Roads-and-Vehicles/Tiwari-Mohan/p/book/9781498751452
13. https://www.amazon.in/Highway-Design-Traffic-Engineering-Handbook/dp/0070382956

Course Title: URBAN PUBLIC TRANSPORT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	20CHT253	CIE Marks	40
Number of Lecture Hours/Week	4:0:0	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students to

1. Understand the various options for urban public transportation and recommend suitable mode for the given situation.
2. Conduct economic analysis between different transport modes and suggest most economical and efficient mode under the given set of conditions.
3. Understand the management of public transport system and developing strategies for efficient functioning of the system.
4. Carry out the evaluation of capacities of the system parameters such as routes, junctions, stations etc, to know the performance of the system.
5. Forecast the future transportation needs and variations in system components so as to plan for the transportation system requirements.

Modules

Module -1

System and Technologies: Urban passenger transportation modes, transit classifications and definitions, theory of urban passenger transport modes, rail transit, bus transit, Metro and Mono Rail, Para transit and ride sharing,
designing for pedestrians, trends in transit rider ship and use of different modes.

Module -2

Comparing Alternatives: Comparing costs, comparative analysis, operational and
Technological characteristics of different rapid transit modes, evaluating rapid transit, Problems.

Module -3

Planning: Transportation system management, system and service planning, financing public transportation, management of public transportation, public Transportation marketing.

Module -4

Transit System Evaluation: Definition of quantitative performance attributes, transit lane capacity, way capacity, station capacity, theoretical and practical Capacities of major transit modes, quantification of performance, Problems.

Module -5

Urban traffic: Classification of transportation systems, conventional transportation systems, non-conventional transportation systems, prototypes and tomorrow's solutions, analysis and interpretation of information on transportation systems, perspectives of future transportation.

Course outcomes:

After studying this course, students will be able to:

1. Understand the various options for urban public transportation and recommend suitable mode for the given situation.
2. Conduct economic analysis between different transport modes and suggest most economical and efficient mode under the given set of conditions.
3. Understand the management of public transport system and developing strategies for efficient functioning of the system.
4. Carry out the evaluation of capacities of the system parameters such as routes, junctions, stations etc, to know the performance of the system.
5. Forecast the future transportation needs and variations in system components so as to plan for the transportation system requirements.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Problem solving.*
- *Critical thinking*
- *Interpretation of data.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. George E. Gray and Lester A. Hoel, 'Public Transportation', Prentice Hall, New Jersey.
2. Vukan R. Vuchic, 'Urban Public Transportation Systems and Technology', Prentice Hall Inc., New Jersey.

Reference Books:

1. Horst R. Weigelt, Rainer E. Gotz, Helmut H. Weiss,' City Traffic - A Systems Digest', Van Nostrand Reinhold Company, New York
2. John W. Dickey,' Metropolitan Transportation Planning', Tata McGraw-Hill Publishing Co. New Delhi.

Course Title: LOW VOLUME ROADS ENGINEERING

[As per Choice Based Credit System (CBCS) scheme]
Semester -II

Subject Code	20CHT254/20CIM254	CIE Marks	40
Number of Lecture Hours/Week	4:0:0	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. To understand the factors affecting pavement design and performance of Rural Roads.
2. To relate the concepts of Highway Geometric design to that of Rural roads
3. To design the Special pavements which form alternatives for Rural Roads.
4. To understand the concepts of design of drainage, CD works and small bridges which form essential structures of Rural roads

Modules

Module -1

Introduction to Low-Volume Roads (LVR). Significance of LVR, Definition, Design Environments. Planning of rural road, planning data base, concept of network planning Rural roads plan, guidelines laid down in recent 20 year plans and in PMGSY Road alignment and surveys, governing factors for route selection Factors controlling alignment; obligatory points, traffic , geometric designs, economy, special considerations in hilly areas.

Module -2

Geometric design standards: classification of rural roads, terrain classification, design speed, basic principles of geometric design cross sectional elements, camber, sight distances
Horizontal alignment: general guidelines, super elevation, transition curve, widening and set back distances, vertical alignment: gradient, grade compensation at curves, valley curves, alignment compatibility, lateral and vertical clearances.

Module -3

Soil and material surveys, soil investigations for low embankment, high embankment, cut sections, subgrade, Survey for marginal materials and aggregates/ low grade materials Artificial aggregates, waste materials, new materials and stabilizers Design parameters, pavement components Design of flexible pavement: pavement thickness, pavement surfacing Design of semi rigid pavement: dry lean concrete / lime flyash concrete bases Design of rigid pavement: cement concrete pavement Design of special pavements: concrete block pavement , interlocking concrete block pavement Choice of pavement type and materials, maximize use of Locally available materials, Use of Geo-synthetics in LVR

Module -4

Types of road drainage, requirements of surface drain; road side drains, shoulder drains, catch water drains. Requirements subsurface drain Cross drains; types, requirements, choice of different types of cross drains Standard designs of culverts Standard design of small bridges.

Module -5

Selection of materials and methodology, construction techniques, machinery and tools.
Construction of Embankment / subgrade; materials, requirements and construction operations. Choice and requirements of coarse sand sub base, gravel roads.
Pavement Maintenance and Rehabilitation Management System (RMS) for LVR

Course outcomes:

1. Get the knowledge of factors affecting pavement design and performance of rural roads
2. The student will be able to differentiate the design and construction of Low volume rural roads with that of the Highways.
3. The students will be able to infer and review the DPRs prepared for construction of Rural Roads such under PMGSY

Graduate Attributes (as per NBA)

- *Critical thinking.*
- *Problem Analysis.*
- *Use of modern tools*
- *Project management and finance*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. S.K. Khanna, C.E.G Justo and A. Veeraragavan, "Highway Engineering"- Nem Chand and Bros., Roorkee. Revised 10th Edition.
2. Robert A. Douglas, Low-Volume Road Engineering, Design, Construction, and Maintenance, I edition, CRC Press

Reference Books:

1. IRC: SP:72-2015, Guidelines for the design of Flexible Pavements for Low Volume Roads, First Revision
2. IRC:SP:62-2014, Guidelines for Design & Construction of CC pavements for low volume roads
3. IRC SP 20 Rural Roads Manual
4. Relevant IRC Publications

COURSE TITLE: PAVEMENT ENGINEERING LAB -II

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	20CHT L26	CIE Marks	40
Number of Lecture Hours/Week	0:4:0	SEE Marks	60
Credits	2	Exam Hours	03

CREDITS – 02

Course objectives:

- The objective of this course is to make students learn
- The procedure and test the basic properties of bitumen and modified binders, learn bituminous mix design
- Learn field tests on pavement evaluation

Modules

Tests on bitumen / polymer modified binders

1. Penetration test
2. Viscosity test
3. Specific gravity test
4. Flash and fire point test
5. Ductility and elastic recovery test
6. Softening point test and separation test
7. Tests on bitumen Emulsion & Cutback bitumen

Tests on bituminous mixes

1. Proportioning of materials by Rothfutch's method and Mix design by Marshall Method.
2. Bitumen Extraction, bitumen content and aggregate gradation

Field Tests on Pavement evaluation

1. Benkelman Beam deflection studies & analysis
2. Measurement of Unevenness by Merlin & Bump integrator - Calibration of Bump Integrator
3. Surface Distress measurements – visual & wind shield survey – Determination of PCI
4. Dynamic Cone Penetration Test

Software Lab

1. Design of Flexible pavements using IIT-PAVE software
2. Design of Rigid Pavements as per IRC:58-2015(MS-Excel)

Course outcomes:

After the completion of the course students should have

- Acquired the expertise to conduct various tests on binder, modified binders and bituminous mixes.
- Gained knowledge on various field tests for the pavement evaluation

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Critical thinking.*
- *Ethical practices and social responsibility*
- *Use of modern tools*

References:

1. Relevant IS and IRC codes
2. S.K Khanna, C.E.G Justo, and A. Veeraragavan., `Highway Materials and Pavement Testing', Nem Chand and Bros, Roorkee
3. Gambhir, M. L., 'Concrete Manual', Dhanpat Rai and sons New Delhi

COURSE TITLE: CONSTRUCTION PLANNING AND ECONOMICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	20CHT31	CIE Marks	40
Number of Lecture Hours/Week	3:0:2	SEE Marks	60
Credits	4	Exam Hours	03

CREDITS – 04

Course objectives:

The objective of this course is to make students learn Highway Planning, Highway Engineering Economics, principle, supply and demand models, equilibrium & sensitivity of travel demand Elasticity, Economic analysis & Highway financing

Modules

Module -1

Various types of highway development projects in progress in India and their scope. Factors to be considered in planning of new highway /expressway / bypass and up-gradation of existing roads.

Planning of Road Projects –project management framework, scope, project objectives, project environment, causes of project failure, project development process

Resource planning – human resources, project man power grouping, structuring site organization, construction materials- classification of construction materials, materials usage, materials inventory, cost and budget.

Module -2

Time planning – project work breakdown, determining activities involved, assessment of duration, CPM / PERT network analysis, work scheduling, methods of work scheduling, factors affecting work scheduling, Problems.

Planning Control System – resource production, project cost, project time, codification and project management, information system, use of software

Use of softwares: Primavera V8i, MSP (Microsoft project), PPM (Project Portfolio Management)

Module -3

Highway Engineering Economics, principle, supply and demand models, equilibrium, sensitivity of travel demand, Elasticities – types, models (Kraft demand model) consumer surplus cost – cost elasticity pricing and subsidy policies, rates of interest, Vehicle operation cost, direct and indirect benefits due to road improvement, Total transportation cost, fixed and variable costs. Road user cost studies in India.

Module -4

Economic analysis, different methods, determination of annual cost, benefit cost ratio, IRR, FIRR, NPV. Sensitivity of economic analysis, Examples of economic analysis for different types of road improvement measures, pavement options, construction of bypasses and upgrading of intersections. Project priorities, methods of dealing with uncertainties.

Module -5

Highway financing, various options for road and bridge projects, special cess, tolling, BOT, BOOT and other options. Economic and financial analysis of highway projects and use of computer software packages. Road investment decision packages.

Use of software: HDM-4 software, Primavera V8i, MSP (Microsoft project), PPM (Project Portfolio Management)

Course outcomes:

On completion of this course,

- Students would be able to prepare highway plans, Land use planning and development models.
- They will be able to carry out economic and financial analysis of highway projects.
- Understand the highway planning process and difficulties or failures associated with planning process.
- Understands the cost of materials, man power and equipment in budget preparations for highway projects.
- Analyse the various tasks involved in a road project and sequence them for effective and optimum outcome using tools like CPM and PERT.

Graduate Attributes

- *Engineering Knowledge.*
- *Problem Analysis.*
- *Critical thinking*
- *Interpretation of data.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 12 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. L.R. Kadiyali "Traffic Engineering and Transport Planning"-Khanna Publishers, New Delhi.
2. K.K. Chitkara. "Construction Project Management Planning, Scheduling and Controlling"-Tata McGraw Hill publications
3. Winfrey, "Economic analysis for Highways", International Textbook Company, Pennslyvania,1969
4. Dr. Vinay Maitri and Dr. P.K. Sarkar "Theory and Applications of Economics in Highway & Transport Planning" Standard Publishers Distributors, Delhi

Reference Books:

1. Prasanna Chandra "Financial Management"-Tata McGraw, New Delhi.
2. Woods K.B, Berry, D.S. and Goetz W.H, "Highway Engineering"-McGraw Hill Book Co.
3. Hewes C.I. and Oglesby, C.H., "Highway Engineering"-Asia Publishing House.
4. Ian G. Heggie, "Transportation Engineering Economics"-McGraw Hill Book Co.
5. "Road User Cost Study in India"- Final Report, Central Road Research Institute, New Delhi, 1982.
6. L.R. Kadiyali, et al, "Value of Travel Time Savings" - Traffic Engineering, HRB
7. Ministry of Road Transport and Highways, "Road Development Plan for India"- 2001-2021, Indian Roads Congress, New Delhi, 2002.
8. IRC "A Manual for the Application of Critical Path Method to Highway Projects in India"
9. Nhai.org, pmgsy.nic.in websites

Standard Data Book on Highway Technology issued by the University may be referred in the PG Examination of VTU.

Course Title: CONSTRUCTION CONTRACT MANAGEMENT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	20CHT321	CIE Marks	40
Number of Lecture Hours/Week	3:0:0	SEE Marks	60
Credits	3	Exam Hours	03

CREDITS – 04

Course objectives:

- This course will enable students to understand the various types of contracts.
- Understand the use and effect of contracts in construction industry

Modules

Module -1

Introduction to contracts: Definitions, Essentials for a legally valid contract, Salient features of contract, Discharging of a contract, Documents for an Engineering Contract; Types of contracts: Classification Based on Tendering Process, Economic Consideration, Applicability of the various types of contracts in Construction.

Module -2

Tendering process: Definitions, List of Documents, EMD, Security Deposit, Invitation for Tenders and sale of Documents, Preparation of Tender Documents and its submission, Receipt of Tender Documents and its opening, Evaluation of Tender and Award of contract–Letter of Award, Letter of Intent, Issues in tendering process: Pre - Registration, Pre-Qualification, Nominated Tendering, Rejection of Tenders, Repeat Orders, Revocation of Tenders, Unbalanced Bidding.

Module -3

Administration/Performance of contract: Responsibilities (Duties and Liabilities) of Principal & Contractor, Monitoring and Quality control/assurance, Settlement of claims − Advances, Bills, Extension for time, Extras & Variations, Cost Escalations. Security Deposit, Retention Money, Performance Bond, Liquidated Damages, Penalties, Statutory Requirements.

Module -4

Breach of contract: Definition and Classification, Common Breaches by – Principal, Contractor, Damage Assessment, Claims for Damages.

Module -5

Dispute resolution: General, Methods for dispute resolution−Negotiations, Mediation, Conciliation, Dispute Resolution Boards, Arbitration, Litigation /Adjudication by courts. Conciliation − Appointment of Conciliator, Role of Conciliator, Special Features of Conciliation Dispute Resolution Boards (DRB), Constitution of DRB, Functioning of DRB, Procedure for Hearings, and Status of Award.

Course outcomes:

After studying this course, students will be able to:

The Students will be able to understand the need of contract management

Steps involved in preparing contracts and types of contracts

Importance of arbitration

Graduate Attributes (as per NBA)

Scholarship of Knowledge.

Problem Analysis.

Design / development of solutions (partly).

Ethical practices and social responsibility

Question Paper Pattern:
The question paper will have ten questions.
Each full question consists of 12 marks.
There will be 2 full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer 5 full
questions, selecting one full question from each
module

Text Books:

1. Albett Robert W., (1961/Latest Edition) "Engineering Contracts and Specifications", John Willey and Sons, New York.
2. Patil B. S. (2009) "Civil Engineering Contracts and Estimates", University Press.

Reference Books:

1. John G. Betty (1993/ Latest Edition) "Engineering Contracts", McGraw Hills.
2. Vasavada B. J., (1997), "Engineering Contracts and Arbitration", (Self Publication by Jyoti B. Vasavada).
3. Vaid K.N., (1998) "Global perspective on International Construction Contracting Technology and Project Management", NICMAR, Mumbai.
4. Prakash V A (1997), "Contracts Management in Civil Engineering Projects", NICMAR, Mumbai.

Course Title: INTELLIGENT TRANSPORTATION SYSTEMS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	20CHT322	CIE Marks	40
Number of Lecture Hours/Week	3:0:0	SEE Marks	60
Credits	3	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Have an awareness and scope of transport issues, such as, traffic safety, public transport, advanced vehicle management and control.
2. Learn how Intelligent transport systems (ITS) involve the application of information technology and telecommunications to control traffic, inform travellers and drivers, operate public transport, automating payments, handle emergencies and incidents, operate commercial fleets and freight exchange, and automate driving and safety.

Modules

Module -1

Introduction To Intelligent Transport System : Definition Objectives, Historical Background, Benefits of ITS – Introduction to Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), Traffic control and monitoring aspects.

Intelligent Supporting Technologies : Wireless communications, Standards and Cellular Technology, ITS Data acquisition and processing, Hardware and Software--Micro-Controllers

Module -2

Intelligent Supporting Technologies: PLC, Embedded systems, Ubiquitous Computing, Sensing Technologies, Detectors/Detection Techniques—Triangulation Technique, Inductive loop detection, Video vehicle detection, Microwave detection etc. Global Positioning System (GPS)

Module -3

Components Of ITS: Theories of elastic and plastic behavior of soils. Function: Stability of embankment, Reinforcing embankment and fibers, Methods of reducing settlement due to consolidation in foundations of road embankment. Vertical Sand Drains: Design criteria, constriction and uses.

Advanced Traveler Information Systems (ATIS): Traffic density, Variable message signs, Parking guidance, Weather information

Advance Vehicle Monitoring Systems : Security CCTV systems, Wireless Sensor Network and RFID

Module -4

Commercial Vehicle Operations (CVO): Emergency Vehicle Notification Systems, Automatic Road Enforcement, Variable Speed Limits, Collision Avoidance Systems, Dynamic Traffic Light Sequence, Cooperative Systems On The Road, Automatic Number Plate Recognition By Image Processing.

Module -5

ITS Applications : Advanced Traffic Management Systems (ATMS) Advanced Vehicle Control Systems (AVCS), Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS), Automated Highway Systems

ITS Programs In the World: Overview of ITS implementations in developed countries, ITS in developing countries.

Course outcomes:

After studying this course, students would be able to suggest the appropriate system/s in various functional areas of transportation.

Would be able to amalgamate the various systems, plan and implement the applications of ITS. Would have learnt the application of information technology and telecommunication to control traffic and also provide advance information to the travellers, automatic handling of emergencies and to improve safety.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Critical thinking.*
- *Ethical practices and social responsibility*
- *Use of modern tools*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Sumit Ghos and Tony Lee, *Intelligent Transportation Systems*, CRC Press, ISBN: 0849300673.
2. Chris Drane andC. R. Drane, *Positioning Systems in Intelligent Transportation Systems*, Artech House Publishers, ISBN: 0890065365.
3. Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House.

Reference Books:

1. Kan Paul Chen, John Miles, "Recommendations for World Road Association (PIARC)" ITS Hand Book 2000.
2. Sussman, J. M., "Perspective on ITS", Artech House Publishers, 2005.
3. US Department of Transportation, "National ITS Architecture Documentation", 2007 (CDROM).
4. Turban. E and Aronson. J. E, "Decision Support Sys tems and Intelligent Systems", Prentice Hall
5. Judy Mc Queen and Bob Mc Queen, *Intelligent Transportation System and Architecture*, Artech House Publishers, ISBN: 089006525X
6. Asad J. Khattak **,** *Intelligent Transportation Systems: Planning, Operations, and Evaluation*, CRC Press

Course Title: SPECIAL PROBLEMS IN ROAD CONSTRUCTION

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	20CHT323/20CIM323	CIE Marks	40
Number of Lecture Hours/Week	3:0:0	SEE Marks	60
Credits	3	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the difficulties of road construction in weak and marshy soils and necessary precautions to be taken during design and construction.
2. Understand the methods of strengthening soil fills and embankments to improve their performance as pavement component layer.
3. Understand the difficulties associated with construction of high embankments and maintaining stability of hill slopes with precautions to be taken.
4. Understand the use of recycled materials in road construction including milled bituminous waste with necessary design methodology.
5. Understand the design and construction of roads in coastal and desert environments with exclusive exposure conditions.

Modules

Module -1

Problems of construction of roads in marshy areas and weak / expansive soils and water- logged - areas. Various effective measures for solving the problems, machinery required and method of construction. Control of water table, capillary rise and seepage flow in road construction. Design and construction of filter drains and capillary cut-off. Construction of subgrade in marshy areas and weak / expansive soils and water- logged - areas.

Module -2

Methods of strengthening weak foundation soil, acceleration of consolidation and settlement of compressible embankment foundation, vertical sand drains -Application, design and construction method.

Module -3

Problems in construction of high embankments, stability of foundation and embankment slopes. Stability of hill slopes, control of erosion.

Module -4

Use of special materials such as geo-synthetics for drainage and in pavement layers. Use of reinforced earth retaining walls, Nailing Technique, Techniques of pavement construction using recycled materials – cold and hot mix recycling of bituminous materials.

Module -5

Special construction techniques - construction techniques of cell filled concrete Pavements – design, economics and construction method, and its application. Road construction on desert region and coastal areas, alternative methods, **Special problems** in construction & maintenance of hill roads, land slide, causes, investigation, and preventive and remedial measures, protection of embankment and cut slopes.

Course outcomes:

After studying this course, students will be able to:

1. Get the knowledge about the difficulties of road construction in weak and marshy soils and the precautions to be taken.
2. Suggest improvement methods of strengthening soil fills and embankments to be a pavement layer.
3. Know the difficulties associated with construction of high embankments and maintaining hill slopes stability.
4. Use recycled materials in road construction with appropriate design methods.
5. Provide design and construction methods for roads in coastal and desert environments.

Graduate Attributes (as per NBA)

- *Critical thinking.*
- *Problem solving.*
- *Ethical practices and social responsibility*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. R.M. Koerner "Designing with Geosynthetics"- 4th Edition Prentice Hall, New Jerssey, 1997.
2. Geotechnical Aspects of Pavements Reference Manual / Participant Workbook U.S. Department of Transportation Publication No. FHWA NHI-05-037 Federal Highway Administration May 2006, https://www.fhwa.dot.gov/engineering/geotech/pubs/05037/05037.pdf
3. Pavement Drainage- Theory and Practice", G.L. Shivakumar Babu, Prithvi S Kandhal, Nivedya Mandankara Kottayi, Rajib Mallick, A. Veeraragavan, CRC Press

Reference Books:

1. IRC-75 "Guidelines for the design of High embankments"- IRC, 2015
2. Leonards G.A. "Foundation engineering"- McGraw Hill Book Company, New York, 1962.
3. Cedgreen H.R. "Drainage of highway and airfield pavement"- John Willey and Sons.Inc., New York, 1974.
4. G. Kassiff M. Livnet. G. Wisemen "Pavements on Expansive clays"– Jerusalem Academy Press, Jerusalem. Israel, 1969.
5. R.D. Krebs & R.D.Walker "Highway Materials"- McGraw Hill Book House, New York, 1971.

COURSE TITLE: SUSTAINABLE CONSTRUCTION [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Subject Code	20CHT324/20CIM324	CIE Marks	40
Number of Lecture Hours/Week	3:0:0	SEE Marks	60
Credits	3	Exam Hours	03
CREDITS – 04			

Course objectives:

This course will enable students to

- Demonstrate competent knowledge of Sustainability, their potentials, their relation, pros and cons;
- Identify specific actions that can be taken to conserve energy and to promote the development and use of renewable energy

Modules

Module 1

Sustainable Construction Materials - Marginal materials, recycled materials, design aspects, construction practices using non-conventional materials and methods, milling and recycling techniques.

Module 2

Energy Savings in Construction - Fundamentals of energy - Energy production systems, Energy and resource conservation, Energy efficient design strategies, Renewable energy sources – advantages and disadvantages; Energy management and conservation: electrical equipment - Improvement of power factor -maximum energy demand.

Module 3

Energy savings in electrical appliances used in buildings (pumps, fans, Compressed air systems, lighting systems, Air conditioning systems):

Energy in building materials, energy efficient and environment friendly building: Thermal comfort and solar radiations

Module 4

Green building rating system: Introduction to IGBC and LEED rating systems – various criteria for building rating.

Module 5

Pollutions and Management: air, water, noise pollutions and reduction measures during planning, design and construction;

Course outcomes:

After studying this course, students will be able to:

- Identify principles of sustainability and its role in construction sector
- Compute the life cycle energy of a typical building
- Develop recycling process for various types of marginal materials
- Characterize marginal materials
- Evaluate recycled products made from marginal materials
- Assess sustainability through rating systems

Graduate Attributes (as per NBA)

- Scholarship of Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Ethical practices and social responsibility

Text Books:

1. K S Jagadish, B V Venkataramana Reddy, K S Nanjunda Rao, "Alternative Buildings Materials and Technologies", New Age International Publishers, New Delhi, 2007
2. K S Jagadish, "Sustainable Building Technologies", IK International Publishers Pvt. Ltd, New Delhi, 2019, ISBN: 978-93-86768-20-9

References

1. Moore F: Environmental Control System McGraw Hill, Inc., 1994.
2. JMPQ Delgado, "Sustainable Materials in Building Construction", Volume 11, Building Pathology and Rehabilitation, Springer, 2020, ISBN 978-3-030-46799-9 ISBN 978-3-030-46800-2 (eBook)
3. Brown, G Z, Sun, Wind and Light: Architectural design strategies, John Wiley, 1985

Course Title: SUSTAINBLE CONCRETE PAVEMENTS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	20CHT331	CIE Marks	40
Number of Lecture Hours/Week	3:0:0	SEE Marks	60
Credits	3	Exam Hours	03

CREDITS – 04

Course objectives:

This course will enable students to

- To provide fundamental understanding of conventional and alternative materials available for the construction of cement concrete pavements.
- To provide thorough knowledge of the various factors influencing the design, construction, performance, and durability of cement concrete pavements.

Modules

Module -1

Introduction to Concrete Pavements: *Concrete Pavements*: Components, functions, factors affecting design and performance; stresses in concrete pavements; concrete pavement design methods; types of concrete pavements and their choice.

Module -2

Material Characterization and Mixture Design: *Materials & Characterization*: Cementitious materials, aggregates, chemical admixtures; *Concrete Properties*: Fresh properties, mechanical properties, durability properties, and characterization; *Mixture Design*: Aggregates blending methods; mix proportioning methods for dry lean concrete, pavement quality concrete, high strength concrete, roller compacted concrete, interlocking paving blocks, and special concrete.

Module -3

Construction and Quality Control, Maintenance, and Rehabilitation: *Conventional Pavements*: Jointed plain concrete pavements, continuously reinforced concrete pavements, fibre reinforced concrete pavements; *Special Types*: White topping, roller compacted concrete pavements, interlocking paving blocks, pervious concrete pavements, precast concrete pavements for highways and airfield; industrial pavements; concrete pavements for low volume road. *Maintenance and Rehabilitation*: Distresses: functional and structural distress in concrete pavements, evaluation of concrete pavements; maintenance, repair, rehabilitation, and retro-fitting techniques

Module -4

Fiber-reinforced Concrete: Brief Introduction on FRC, Mix design of FRC, behaviour of hardened FRC under compression, tension flexure and impact, SIFCON, Ductal Concrete.

Concrete Fracture Mechanics - Brief introduction, Fracture Mechanics in Concrete - Concept.

Module -5

Recycled concrete: Introduction, properties of recycled aggregate, Methods of recycling and quality, Applications.

Waste Materials in Concrete: Introduction, waste material, waste glass, waste

Plastic and waste rubber. Brief introduction on low strength mortars and its applications.

Course outcomes:

After studying this course, students will be able to:

1. Develop a strategy to assess the suitability of different materials and concrete mixes for rigid pavements.
2. Compare and design different types of long-lasting paving quality concrete mixes.
3. Develop strategies to construct, maintain, and repair various types of cement concrete pavements.
4. Determine the compressive strength of concrete structures by Non Destructive Methods.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Problem Analysis.*
- *Design / development of solutions (partly).*
- *Ethical practices and social responsibility*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Delatte N. J., Concrete Pavement Design, Construction, and Performance, CRC Press, Taylor & Francis Group, 2014.
2. A. M. Neville, Properties of Concrete, Pearson Education (Singapore) Pvt. Ltd.

Reference Books:

1. Peter C. Taylor, Steven H. Kosmatka, Gerald F. Voigt, et al., Integrated Materials and Construction Practices for Concrete Pavement: A State-of-the-Practice Manual. Report No. FHWA HIF-07 – 004, 2007. Available online at https://intrans.iastate.edu/app/uploads/2019/05/IMCP_manual.pdf . Accessed on March 17, 2020
2. Neville, A.M., Properties of Concrete, Fifth Edition, Pearson, 2012.
3. Mehta, P. K., and Monteiro, P. J. M., Concrete: Microstructure, Properties, and Materials, Mc Graw Hill, Fourth Edition, 2013.
4. Griffiths, G., and Thom, N., Concrete Pavement Design Guidance Notes, First Edition, CRC Press, 2019.
5. Harrington, D., Abdo, F., Adaska, W., and Hazaree, C., Guide for Roller Compacted Concrete Pavements, Portland Cement Association, 2010.
6. Tayabji S., Precast Concrete Pavement Technology Implementation, Report No. FHWA-HIF-19-013, 2019.
7. All relevant codes/standards from Indian Roads Congress (IRC), Bureau of Indian Standards (BIS), American Society of Testing Materials (ASTM), and American Association of State Highway and Transportation Officials (AASHTO)

Course Title: GIS AND REMOTE SENSING APPLICATIONS IN TRANSPORTATION ENGINEERING

[As per Choice Based Credit System (CBCS) scheme]

Semester -III

Subject Code	20CHT332	CIE Marks	40
Number of Lecture Hours/Week	3:0:0	SEE Marks	60
Credits	3	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. To learn the basic concepts Geographical Information System (GIS), Remote Sensing (RS),
2. To understand these basic concepts in context of transportation and transportation networks.
3. To learn the data needs and database development for doing transportation analysis in GIS environment.
4. To understand the concepts of transportation networks and algorithms and how they are incorporated into GIS.
5. To understand how GIS processes can be used for efficient transportation modeling and analysis.
6. To understand various applications of GIS in Transportation (GIS-T) including Intelligent Transport Systems (ITS) and learn from some case studies.

Modules

Module -1

Concept of GIS and RS. Development of GIS and RS over the period. GIS for transportation in perspective. GIS, GPS and Transportation.

Land use and Transportation Data: Spatial and Non spatial data for land use and transportation. Traffic Analysis Zone (TAZ) and screen lines. Network and Routes.

Module -2

Data base Development: Database domains and transactions. RDBMS and Entity Relationship (ER) diagram. Data base design. Map Generation and Analysis Concept of map layers. Land cover analysis. Network creation and linear route building. Map accuracy and location expression. Generation of Themes and charts.

Module -3

Transportation Network Development and Algorithms: Network development and management. Network properties. Shortest path algorithms. Transit network and paths.

Module -4

GIS-T applications: Background and trends of GIS-T application. GIS-T application areas. Intelligent Transport Systems (ITS): Components of ITS. Architecture and integration with GIS. Analysis and visualizations of traffic data in GIS. Integration of GPS and GIS. Case Studies.

Module -5

Transportation, Environment and Hazards: Mapping sensitive Environmental features; GIS and Transportation related Air Quality; Accidents and Safety
Analysis; Transportation of hazardous Materials.

Course outcomes:

1. Identify the geospatial data and tools required for understanding the transportation systems.
2. Use geospatial methods to analyze the transportation network problems.
3. Apply the geospatial methods in transportation modelling systems.
4. Demonstrate the use of geospatial methods in transportation safety and air quality analysis.

Graduate Attributes (as per NBA)

- *Critical thinking.*
- *Problem Analysis.*
- *Use of modern tools*
- *Project management and finance*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. O'sullivan David, Geographic Information Analysis, John Wiley & Sons, 2003.
2. Longley P. A., Barnsley M. J., Donnay Jean-Paul, Remote Sensing and Urban Analysis, Taylor & Francis, 2001.

Reference Books:

1. Hensher D. A., Button K. J., Haynes K. E., and Stopher P. R. (Eds.), Handbook of Transport Geography and Spatial Systems, Elsevier, 2004.
2. Thill Jean-Claude, Geographical Information Systems in Transportation Research, Pergamon, 2000.
3. Caliper Corporation, Travel Demand Modelling with TransCAD, 1998.
4. Michael W., GIS - A Computing Perspective, CRC Press, 2004.
5. Miller HJ and Shaw SL, Geographic Information Systems for Transportation: Principles and Applications, Oxford University Press,2001.
6. Implementation of GIS in State DOTs, NCHRP Report No:180.
7. Simlowitz HJ. GIS Support Transportation System Planning. International GIS Sources Book.
8. Hill JC, GIS in Transportation, Transportation Research Part C & 2000.

Course Title: TRANSPORTATION PLANNING
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject Code	20CHT333	CIE Marks	40
Number of Lecture Hours/Week	3:0:0	SEE Marks	60
Credits	3	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the different modes of transportation and factors affecting planning process for an effective transportation system.
2. Understand the characteristics of mass transit system and methods of collecting traffic data to propose an effective transport facility.
3. Understand and sources of zonal trip generation or attraction and then inter-zonal trip distribution methods.
4. Analyse the mode of transport and its impact on transport system and also the methods of assigning travel trips to various routes for effective management.
5. Understand the mass transportation options and evaluation of the systems for economic sustainability.

Modules

Module -1

Urbanization Process: Urban growth mechanism – Urban morphology - Urbanisation & travel demand - Urban development planning policy – NUTP - Urban transport projects - Urban transport problems in India.**Urban Transport Planning Process:** Urban travel patterns - Study area delineation- Zoning - Planning surveys - Urban activity system- Sustainable urban transport - Systems approach.

Module -2

Travel Demand Estimate: Trip based and activity based approach - Four stage travel demand modeling - Data needs and outputs - Quick response techniques - Survey designs.
Trip Generation: Productions & Attractions - Influential factors –Trip rate analysis-Category analysis-Simple & Multiple linear regression models – FHWA method.

Module -3

Trip Distribution: Interchange matrix – Growth factor methods – Synthetic methods calibration of Gravity model.
Modal Split : Influential factors – FHWA Procedure – Diversion curves & surfaces- Discrete choice models, Concept, Types, BL,MNL & HL models

Module -4

Trip Assignment: Trip Assignment procedure – Diversion curves- BPR model - All or Nothing assignment - Multipath assignment - Capacity restraint assignment – User equilibrium and system equilibrium approach - Stochastic assignment approach.

Module -5

Land Use Transport System: Urban system components - Urban spatial structure Accessibility - Location theory - Land use models - Land use transport models, Lowry & Garin – Lowry models**.**
Urban public transportation: Urban growth and public transport needs - Transit mode classifications – Transit characteristics - Fleet size and capacity estimation
Use of softwares: TransCAD, CUBE

Course outcomes:

After studying this course, students will be able to:

1. Get the knowledge of different modes of transportation and factors affecting the planning process for the different modes.
2. Propose effective transport facility for the mass transportation after collecting the data required.
3. Compute the inter-zonal trip generations or attractions and also the trip distributions.
4. Analyse the impact of transport mode on the transport system to understand effective management along the routes.
5. Evaluate the economic sustainability of the mass transportation systems.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Problem solving.*
- *Usage of modern tools*
- *Interpretation of data.*

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 12 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Hutchinson, B.G., "Principles of Urban Transport System Planning"– McGraw Hill Book Co.
2. L.R. Kadiyali, "Traffic Engineering and Transportation Planning"– Khanna Publication.
3. Khisty C J., Lall B.Kent, *Transportation Engineering – An Introduction, Prentice*-Hall, NJ, 2005
4. Ortuzar, J. D., Willumsen, L.G., *Modeling Transport*, John Wiley & Sons, 1994
5. Papacostas C.S. and Prevedouros, P.D., *Transportation Engineering & Planning*, PHI, New Delhi,2002
6. Chakroborty P., Das N., *Principles of Transportation Engineering*, PHI,New Delhi,2003
7. Dickey J.W., *Metropolitan Transportation Planning*, Tata Mc-Graw Hill 1980

Reference Books:

1. Nicholas J.Garber, Lester A. Hoel, "Traffic and Highway Engineering", Third Edition Thompson Learning
2. Institute of Traffic Engineers – "An Introduction to highway Transportation Engineering", ITE, USA
3. Bowmen, J. and M. ben-Akiva, *Activity based travel Forecasting; in Activity based travel forecasting*. Washington, DC: U.S. Department of Transportation, Report DOT-97-17.
4. Bruton M.J., *Introduction to Transportation Planning*, Hutchinson of London, 1988

COURSE TITLE: CONSTRUCTION DEMOLITION AND WASTE MANAGEMENT [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Subject Code	20CHT334/20CIM334	CIE Marks	40
Number of Lecture Hours/Week	3:0:0	SEE Marks	60
Credits	3	Exam Hours	03
CREDITS – 04			

Course objectives:

This course will enable students to

- Focus on the principles of sustainable construction and demolition waste management and resource efficiency
- Examining the environmental impact of building materials;
- Formulating and designing pre−construction and site waste management plans

Modules

Module 1

Environmental Impact of Building Materials Embodied energy of materials; impact on the local environment; toxicity of the material; life cycle assessment. Nature and Source Direct and indirect waste; site types and origins; composition; quantity; current recycling/reuse potential of building materials.

Module 2

Construction and Demolition Waste Management Plans International good practice; planning requirements; DoEHLG guidance document; company policy; demolition plans; site implementation; supplier agreements; sub−contractor management; role of waste management contractor; training; auditing; skip management; current markets; current disposal options; health and safety; reporting to local authorities.

Treatment of Construction and Demolition Waste, waste permits; waste licenses; waste transfer facilities; landfills; treatment technologies; hazardous waste facilities; reporting to EPA

Module 3

Designing for Waste Prevention and Minimization, Waste prevention and minimization; client, contractor and designer attitudes; proper maintenance of existing buildings; reuse of existing building structure; design flexibility; design for reuse and recycling; dimensional co−ordination and standardization; modular design; material selection and control.

Module 4

Waste Forecasting Tools Application of WRAP's designing out waste tool for buildings and civil engineering; WRAP net waste tool; BRE SMART Waste; WRAP Site Waste Management Plan Tracker.

Module 5

Future developments Potential future markets; ‘smart' materials; use of eco−materials.

Course outcomes:

After studying this course, students will be able to:

- They can able to understand the basic concept of embodied energy of construction materials.
- Understand the application of construction and demolition waste to various concrete structures.

Graduate Attributes (as per NBA)

- *Scholarship of Knowledge.*
- *Problem Analysis.*
- *Design / development of solutions (partly).*
- *Ethical practices and social responsibility*

Text Books:

1. Springer, "Recycling and Resource Recovery Engineering", Springer – Verlag, Berlin Heidelberg (1996)
2. Greg Winkler, "Recycling Construction and Demolition waste: A LEED - Based Toolkit (Green Source) (Google ebook), McGraw Hill Professional

References:

1. V M Tam, Chi Ming Tam, "Reuse of Construction and Demolition Waste in Housing Development", Nova Science Publishers, 2008.
2. JMPQ Delgado, "Sustainable Materials in Building Construction", Volume 11, Building Pathology and Rehabilitation, Springer, 2020, ISBN 978-3-030-46799-9 ISBN 978-3-030-46800-2 (eBook)
3. Current Literature.